Lecture 6: New Economic Geography

Yuan Zi

University of Oslo (yuanzi.economics@gmail.com)

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Introduction

- Economic geography received relative little attention until the early 1990s
- Despite the fact that
  - Production, trade and income are distributed extremely unevenly across physical space
  - Agglomeration of overall economic activity most evident in cities
    - By 1990, 37.6 % of the world's population lived in cities
    - By 1995, 15 cities with a population > 10 million
  - Geographical concentration of particular activities
    - US manufacturing belt in NE and Eastern Midwest
    - Dalton as a carpet manufacturing centre in Georgia
    - Silicon Valley and Route 128 in Massachusetts

What is economic geography?

- What do we mean by economic geography?
  - Location of economic activity in space
  - First-nature geography: Physical geography of coasts, mountains and endowments of natural resources
  - Second-nature geography: The spatial relationship between economic agents
- Our analysis will largely focus on second-nature geography: How does the *spatial* relationship between agents determine how they interact, what they do, and how well off they are?

Agglomerations

The occurrence of agglomerations raises several questions:

- How come that economic activity is agglomerated instead of evenly spread out across space?
- What implications do agglomerations have for welfare and economic policy?
- How do increased globalization and integration affect the number, size, and localization of industrial agglomerations?

Self-reinforcing agglomerations

- An agglomeration is self-reinforcing when the profitability of a firm is determined by the localization of other firms.
- In other words, self-reinforcing agglomerations rely on the existence of localized external economies of scale.
- Implications
    - The existence of multiple equilibria
    - Irreversibility
    - Critical mass
    - History (path dependence)
    - (Self-fulfilling) expectations

Today's lecture

- Introduction
- Krugman and Helpman (1985)
- Krugman (1991)
- Empirical evidence

Helpman and Krugman (1985)

Helpman and Krugman (1985)

- Problem with Krugman (1980) models: no room for specialization (single differentiated good)
- How does intra-industry trade affect specialization patterns?
- Assume there are 2 sectors: one with a differentiated good (IRS, for instance with CES production function, etc.), the other with an homogenous good produced under CRS, freely traded.
- Consumer spend a fixed share μ of their budget in differentiated goods, and the marginal productivity in the CRS sector is normalized to 1 in both countries (implies that wages are equalized across countries as labor is mobile across sectors)

Helpman and Krugman (1985)

- For the differentiated good we have

  $q = q^D + \tau q^X = \mu(\frac{p}{P})^{-\sigma}\frac{wL}{P} + \tau\mu(\frac{\tau p}{P^*})^{-\sigma}\frac{wL^*}{P^*}$

- Since $q = q^*$ (why?) we can show that

  $n(1 - \tau^{1-\sigma}\frac{L}{L^*}) = n^*(\frac{L}{L^*} - \tau^{1-\sigma})$

- Which we can use to compute the allocation of differentiated producers across countries as function of L/L^* and τ

- Denote $s_n = \frac{n}{n+n^*}$ and $s_L = \frac{L}{L+L^*}$

Helpman and Krugman (1985)

- We have $s_n = \frac{s_L(1+\tau^{1-\sigma})-\tau^{1-\sigma}}{1-\tau^{1-\sigma}} \Rightarrow \frac{ds_n}{ds_L} > 0$
- For $s_L < \frac{\tau^{1-\sigma}}{1+\tau^{1-\sigma}}$ or $s_L > \frac{1}{1+\tau^{1-\sigma}}$: full specialization of one country in the production of the differentiated good
- The smaller τ, the small the interval of size where both countries produce the differentiated good
- If s_n lies in the interval, the larger country host a higher share of output than its share of global population:

  $s_n = s_L + \frac{1}{2}\frac{\tau^{1-\sigma}}{1-\tau^{1-\sigma}}(s_L - \frac{1}{2}) > s_L$ if $s_L > 1/2$
- Moreover we have $\frac{ds_n}{ds_L} > 1$: the share of output grows faster than the share in population $\Rightarrow$ **Home Market Effect**

Comments

- Transport costs, increasing returns to scale and love of variety provide forces of agglomeration (forward & backward linkages)
- Mobility of manufacturing workers is central and, therefore, the model may be more applicable within than between countries
- We can add immobile production factors to provide a force for deagglomeration/dispersion.

Krugman (1991)

The model

- An economy with two locations: North and South
- Two goods:
  - Agricultural goods:Homogenous, perfect competition and CRS
  - Manufacturing goods: Differentiated, monopolistic competition and IRS
- There are two factors (a specific factors model)
  - Workers used only in the manufacturing sector and geographically mobile, $L_M = \mu$
  - Farmers used only in the agricultural sector and geographically immobile
    - Each region endowed with $L_A^i = (1 - \mu)/2$ farmers

Consumption and production

- Consumer preferences

$$U = C_M^{\mu} C_A^{1-\mu}$$

$$C_M = \left[\sum_j c_j^{\frac{\sigma-1}{\sigma}} \right]^{\frac{\sigma}{\sigma-1}}, \quad P_M = \left[\sum_j p_j^{1-\sigma} \right]^{\frac{1}{1-\sigma}}, \sigma > 1$$

- Production
    - Agriculture

$$Z = L_A$$

    - Manufacturing

$$L_{Mj} = \alpha + \beta x_j$$

    - Transportation costs
      - No transportation costs in agriculture
      - Iceberg transportation costs $\tau > 1$ in manufacturing sector
      $\rightarrow$ Normalize agriculture price and wage to one. Denote manufacturing wage as w

Producer equilibrium (as in Krugman 1980)

- Profit maximization given the CES consumer demand implies firms charge a constant markup over produced varieties

$$p_j = p = \left(\frac{\sigma}{\sigma - 1}\right)\beta w, \qquad \forall j$$

- Free entry implies zero equilibrium profits

$$(p - \beta w)\, x_j = \alpha w,$$

implies a constant equilibrium output of each variety

$$x_j = \frac{\alpha(\sigma - 1)}{\beta}, \qquad \forall j$$

The wage equation

- For each firm supply=demand. This yeilds equilibrium wage at each location

$$x = \left[\mu Y^N \left(p^N\right)^{-\sigma} \left(P^N\right)^{\sigma-1} + \mu Y^S \left(p^N\right)^{-\sigma} \left(P^S\right)^{\sigma-1} \tau^{1-\sigma}\right],$$

$\Longrightarrow$

$$w^N = \frac{\sigma-1}{\sigma\beta} \left(\frac{\mu}{x}\right)^{\frac{1}{\sigma}} \underbrace{\left[Y^N \left(P^N\right)^{\sigma-1} + Y^S \left(P^S\right)^{\sigma-1} \tau^{1-\sigma}\right]^{\frac{1}{\sigma}}}_{\text{Market access for firms at location N}}.$$

Similarly

$$w^S = \frac{\sigma-1}{\sigma\beta} \left(\frac{\mu}{x}\right)^{\frac{1}{\sigma}} \underbrace{\left[Y^N \left(P^N\right)^{\sigma-1} \tau^{1-\sigma} + Y^S \left(P^S\right)^{\sigma-1}\right]^{\frac{1}{\sigma}}}_{\text{Market access for firms at location S}}.$$

Number of Varieties

Equilibrium number of manufacturing varieties

$$n_M = \frac{L_M}{\alpha + \beta x} = \frac{L_M}{\alpha \sigma}$$

Real wages and regional incomes

- Equilibrium real wage of manufacturing workers

$$\omega_M^N = \frac{w_M^N}{\left(P_M^N\right)^{\mu}\left(p_A^N\right)^{1-\mu}}$$

- Equilibrium regional income

$$Y^N = w_M^N L_M^N + \left(\frac{1-\mu}{2}\right)$$

Convenient Normalizations

- Choice of units to measure output of manufacturing varieties

$$\beta = \frac{\sigma - 1}{\sigma} \Rightarrow p_M = w_M$$

- Choice of units with which to count manufacturing varieties

$$\alpha = \frac{\mu}{\sigma} \Rightarrow \begin{cases} n_M = \frac{L_M}{\mu} \\ x = \mu \end{cases}$$

- Denote North's share of manufacturing workers by λ and hence South's share by $(1 - \lambda)$.

Determination of Equilibrium

Eight simultaneous non-linear equations in eight unknowns

- Income

$$Y^N = \mu\lambda w_M^N + \left(\frac{1-\mu}{2}\right); \qquad Y^S = \mu\left(1-\lambda\right)w_M^S + \left(\frac{1-\mu}{2}\right)$$

- Price Indices

$$P_M^N = \left[\lambda\left(w_M^N\right)^{1-\sigma} + \left(1-\lambda\right)\left(w_M^S\tau\right)^{1-\sigma}\right]^{1/(1-\sigma)}$$

$$P_M^S = \left[\lambda\left(w_M^N\tau\right)^{1-\sigma} + \left(1-\lambda\right)\left(w_M^S\right)^{1-\sigma}\right]^{1/(1-\sigma)}$$

Determination of Equilibrium cont

- Nominal Wages

$$w_M^N = \left[Y^N \left(P_M^N\right)^{\sigma-1} + Y^S \left(P_M^S\right)^{\sigma-1} \tau^{1-\sigma} \right]^{\frac{1}{\sigma}}$$

$$w_M^S = \left[Y^N \left(P_M^N\right)^{\sigma-1} \tau^{1-\sigma} + Y^S \left(P_M^S\right)^{\sigma-1} \right]^{\frac{1}{\sigma}}$$

- Real Wages

$$\omega_M^N = \frac{w_M^N}{\left(P_M^N\right)^{\mu}}$$

$$\omega_M^S = \frac{w_M^S}{\left(P_M^S\right)^{\mu}}$$

Price Index

- The location with a larger manufacturing sector also has a lower price index for manufacturing goods
  - Because a smaller proportion of the region's manufacturing consumption bears transport costs

$\Rightarrow$ Forward linkage: workers wish to be close to abundant supplies of manufacturing goods

Market access effect

- Increasing returns to scale implies that producers wish to concentrate production in a single location
- Transport costs imply that they wish to concentrate production close to a large market

$\Rightarrow$ Backward linkage: firms wish to locate production close to large markets for manufacturing goods

Home Market Effect, Nominal and Real Wages

Home market effect

- Implies a 1 percent change in manufacturing demand leads to a more than proportionate increase in manufacturing production
  - Magnification effect – caused by IRS + trade cost

    - IRS, no trade cost → production locate at one place, but can be any place (production concentration)
    - IRS, positive trade cost → *tend to* located near big market
  - Contrast with predictions under CRS + trade cost

    - CRS, no trade cost → production can locate anywhere (spread/concentrate)
    - CRS, positive trade cost → spread production co-locate with consumption
- Implies that locations with higher demand for manufactures will tend to pay higher nominal wages
- Price index and home market effects imply that locations with more manufacturing sectors will, other things equal, pay higher real wages

⇒ Forward and Backward linkages together provide forces of Cumulative Causation

Sustainability of a Core-Periphery Pattern

- Suppose that all manufacturing is concentrated in the North. When is this an equilibrium?
  - Set $\lambda = 1$ and guess $w_M^N = 1$
  - Then confirm $w_M^N = 1$ is indeed an equilibrium from the Northern wage equation

$$Y^N = \left(\frac{1+\mu}{2}\right) \qquad Y^S = \left(\frac{1-\mu}{2}\right)$$

Sustainability of a Core-Periphery Pattern cont

- Price Indices

$$P_M^N = 1$$

$$P_M^S = \tau$$

- Real Wages

$$\omega_M^N = 1$$

$$\omega_M^S = \tau^{-\mu} \left[\left(\frac{1+\mu}{2} \right) \tau^{1-\sigma} + \left(\frac{1-\mu}{2} \right) \tau^{\sigma-1} \right]^{\frac{1}{\sigma}}$$

- The concentration of manufacturing in the North will be an equilibrium if and only if $\omega_M^S < 1$, i.e. workers in the North do not have any incentive to move to the South.

Determinants of the Sustain Point

- Sustainability of a Core-Periphery Pattern

$$\omega_M^S = \tau^{-\mu}\left[\left(\frac{1+\mu}{2}\right)\tau^{1-\sigma} + \left(\frac{1-\mu}{2}\right)\tau^{\sigma-1}\right]^{\frac{1}{\sigma}}$$

- Solve for the level of transport costs (Sustain point T(S)) at which $\omega_M^S < 1$ and a core-periphery pattern is sustainable
  - When will a worker wish to move to the South?

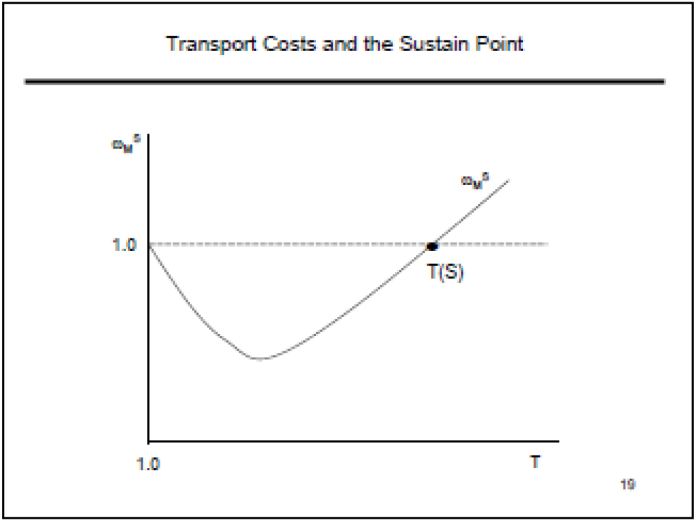
Determinants of the Sustain Point

Transport costs and the Sustain Point

$$\left(\omega_M^S\right)^\sigma = \left[\left(\frac{1+\mu}{2}\right)\tau^{1-\sigma-\mu\sigma} + \left(\frac{1-\mu}{2}\right)\tau^{\sigma-1-\mu\sigma}\right]$$

- When $\tau = 1$ (no transport costs), location is irrelevant : $\omega_M^S = 1$
- At low levels of transport costs, $\tau > 1$: Agglomeration is sustainable because $\omega_M^S < 1$.
- At high levels of transport costs,$\tau > 1$:
  - First term above becomes arbitrarily small
  - Second term has two possibilities:
    - If $(\sigma - 1) < \mu\sigma$, it becomes arbitrarily small and agglomeration forces are so strong that a core-periphery pattern is always an equilibrium
    - We typically assume $(\sigma - 1) > \mu\sigma$ (no black hole condition): Core-periphery pattern only an equilibrium for levels of transport costs below the sustain point *TS*

The polarized world



When is a Symmetric Equilibrium Broken?

- Consider a symmetric equilibrium

$$\lambda = 1/2$$

$$Y^N = Y^S = 1/2, \qquad w^N = w^S = 1$$

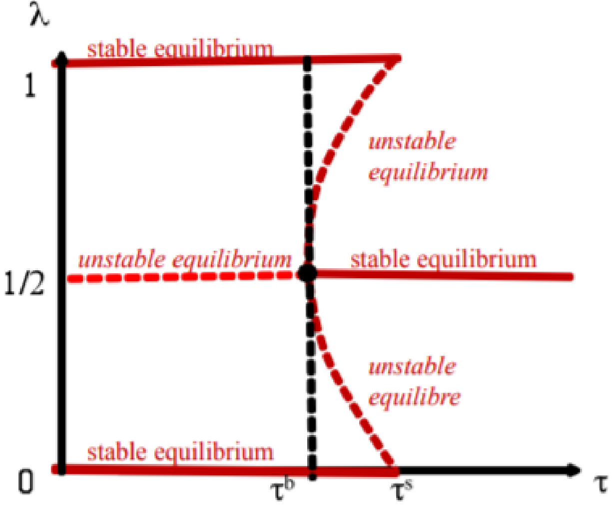
$$P_M^N = P_M^S = \left[\frac{1+\tau^{1-\sigma}}{2}\right]^{\frac{1}{1-\sigma}}$$

- Check that all equilibrium conditions satisfied at these values for the endogenous variables
- Totally differentiate around the symmetric equilibrium and evaluate the impact of worker moving S to N on the real wage gap $\omega = \omega^N - \omega^S$

$$\frac{d\omega}{d\lambda} = 0 \quad \text{if} \quad \tau^{\frac{\rho}{1-\rho}} = \frac{(\rho+\mu)(1+\mu)}{(\rho-\mu)(1-\mu)} \equiv T(B), \quad \rho = \frac{\sigma-1}{\sigma}$$

When $\tau < T(B)$, the symmetric equilibrium becomes unstable

Spatial equilibrium and transportation cost: the 'Tomahawk ' diagram



Empirical evidence

Head and Ries (1999)

- Head and Ries (1999), "Rationalization effect of tariff reductions", *Journal of International Economics*
- Evidence from the US-Canada Free Trade Agreement (1988)
- Study 230 Canadian manufacturing industries between 1981 and 1994

Head and Ries (1999)

Table 3
Effects of tariffs on log output per plant (ln q)

	Sample:				
	All	Imp. Com.	IC+Free	IC+Fixed	All
Canadian Tariff	1.134[a]	1.247[a]	0.279	3.824[a]	4.928[a]
	(0.368)	(0.411)	(0.455)	(0.925)	(1.135)
U.S. Tariff	−1.638[a]	−2.227[a]	−0.937	−5.632[a]	−6.371[a]
	(0.596)	(0.716)	(0.828)	(1.403)	(2.078)
Cdn. Tariff					−17.952[a]
× Turnover					(5.489)
U.S. Tariff					20.131[c]
× Turnover					(10.289)
1994	0.179[a]	0.172[a]	0.117[a]	0.301[a]	0.186[a]
	(0.020)	(0.022)	(0.025)	(0.040)	(0.021)
R^2 (within)	0.175	0.173	0.129	0.338	0.191
Root MSE	0.149	0.152	0.149	0.154	0.149
No. of Obs.	1828	1628	1183	445	1693

Note: Fixed industry year effects are not reported except for 1994 which approximates the percent change from 1988. Standard errors in parentheses. [a], [b], [c] indicate significance in a two-tail test at the 1, 5 and 10 percent levels.

- Opposite effect of US and Canadian tariff reduction on output by firm
- In net firm size did not change much

Head and Ries (1999)

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- Effect depends on whether there is free entry or not, imperfect competition or not

Head and Ries (1999)

Table 4
Effects of tariffs on log # of plants (ln n)

	Sample: All	Imp. Com.	IC+Free	IC+Fixed	All
Canadian Tariff	1.352[a]	1.629[a]	1.957[a]	−0.384	−2.015[b]
	(0.264)	(0.286)	(0.305)	(0.719)	(0.783)
U.S. Tariff	1.218[a]	0.953[c]	1.143[b]	1.781	2.579[c]
	(0.428)	(0.499)	(0.554)	(1.090)	(1.433)
Cdn. Tariff					14.634[a]
× Turnover					(3.786)
U.S. Tariff					−2.195
× Turnover					(7.097)
1994	−0.111[a]	−0.099[a]	−0.087[a]	−0.14[a]	−0.142[a]
	(0.014)	(0.015)	(0.017)	(0.031)	(0.014)
R^2 (within)	0.438	0.436	0.506	0.290	0.498
Root MSE	0.107	0.106	0.100	0.119	0.103
No. of Obs.	1828	1628	1183	445	1693

Note: Fixed industry and year effects are not reported except for 1994 which approximates the percent change from 1988. Standard errors in parentheses. [a], [b], [c] indicate significance in a two-tail test at the 1, 5 and 10 percent levels.

- Strange results on the number of plants

Conclusion

- Problems of the Krugman models: homogeneous firms, factors immobile across countries

- Next lectures: New economic geography, heterogeneous firms: relax these assumptions

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